

Determination of optimum tapping date for gum arabic production in South Kordofan State, Sudan

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Abstract: *Acacia senegal*, the gum arabic producing tree, is the most important tree species for the livelihood of the people in South Kordofan State, Sudan. The objective of this study was to determine the optimum tapping date for gum arabic production in the study area. A randomized complete block design experiment with three replications was conducted at (Meari) area for two continuous growing seasons 2008/2009 – 2009/2010. The treatments comprised six tapping dates (1 Oct, 15 Oct, 1 Nov, 15 Nov, 1 Dec, and 15 Dec). Results showed highly significant differences ($p < 0.001$) in gum arabic yield (g/tree) in all pickings and in the total gum yield between the tapping dates. The results also showed that tapping of trees on 15 October and 1 November gave a higher yield compared to the other dates. The highest gum yield of 1086.6 and 661.2 g/tree was recorded on 15 October and 15 November, while the lowest gum yield of 297.9 g/tree was recorded when the trees were tapped on 1 October. The two highest-yield dates of tapping (15 Oct and 1 Nov) are recommended as the best time for tapping for gum arabic production in South Kordofan State. These results can be used to increase gum arabic production and farmer income in South Kordofan State.

Keywords: gum Arabic; date of tapping; agroforestry system; South Kordofan; Sudan

Introduction

Gum arabic is defined as the dried exudates obtained from the stems and branches of *A. senegal* and related species (Awouda

1974; FAO 1990). More than 80% of the total gum arabic is collected from *A. senegal* which grows naturally in the gum belt of Sudan. The annual trade of gum arabic is worth around 45 million US\$ (Beshal 1984; Larson and Bramely). The economic importance of gum arabic has been acknowledged by many authors (Coe and Beentje 1991; Coppen 1995; Ballal 1991, 2002). In areas too dry to support agriculture and livestock production, gum arabic is often the principal source of revenue for semi-nomadic people (NAS 1979). *A. senegal* has a high potential in agroforestry systems because it is a leguminous tree that can fix atmospheric nitrogen and thus improve soil fertility and increase crop yield (Ballal and Hamid 2000). The importance of the tree as an integral component of traditional dry-land agroforestry was reported by Raddad (2006) and Fadl and Gebauer (2004). Traditionally, gum production in Sudan is part of a bush fallow system where *A. senegal* is rotated with field crops such as millet (*Penisetum glaucum*), sorghum (*Sorghum bicolor*), groundnut (*Arachis hypogea*), sesame (*Sesamum indicum*) and watermelon (*Citrullus lanatus*) in a fallow rotation of 10–15 years (Hussein 1983; Badi et al. 1989; Ballal 1991). The influence of tapping date on gum yield in relation to stand type and management in North Kordofan State was reported by Ballal (2008) who stated that “the optimum tapping date of plantations and managed natural stands of *Acacia senegal* in North Kordofan is during the period from 1 to 15 October”. He also mentioned that the farm gardens and natural farm stands of *A. senegal* in North Kordofan should be tapped from 1 October to 1 November.

In recent years, the traditional *A. senegal* agroforestry system has been disrupted due to misuse of lands, drought, desertification, the massive increase in human and animal population, and the overall declining trend in gum arabic yield, all these factors collectively lead to the decrease in gum production and supply (Awouda 2000; Ballal 2008, Fadl and Gebauer 2004). However, there is no recommendation on optimum tapping date for gum arabic production in South Kordofan State and in natural stands of gum arabic trees. The objective of this study was to determine the optimum tapping date for gum arabic production in South Kordofan State.

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Materials and methods

This study was conducted at (Meari) village, which is located at Northwestern Kadugli, the capital of South Kordofan State (about 25 Km from Kadugli). South Kordofan State covers an area of 199.37 km², lying between latitudes 9–14° N and longitudes 27–32° E. The climate in the study area is semi-humid with highly seasonal rainfall ranging between 400–800 mm. The soil in the area is classified into three soil types, heavy cracking soils (Vertisol) in the southern part of the state, the Goz sandy ridges alternating with cracking clay in the eastern and northern part of the state and the gardud soil interspersed between the clay and sandy soils. The vegetation cover of the state is characterized by Savannah forest tree species.

A one-factor randomized complete block design (RCBD) experiment with three replications was conducted for two seasons 2008/2009 and 2009/2010 at Meari natural stand, where tree age ranged between 15–25 years. The treatments comprised six dates of tapping starting from 1 October to 15 December with a 15-days interval between tapping dates. Ten trees in each experimental unit were randomly selected for tapping. The data collected were gum yield per tapping from first tapping through sixth tapping. Gum collected and weighed 45 days after tapping, gum yield was recorded in grams per tree. The gum from each picking was weighed after drying using a sensitive balance. Data were subjected to statistical analyses using computer program

MSTAT-C statistical package (Fisher 1990).

Results and discussion

In the 2008/2009 season yields differed significantly by date of tapping ($p < 0.001$) for all tappings except the fifth tapping (Table 1). Tapping on 15 October and 1 November yielded 1038.5 g and 482.3 g, respectively, both significantly higher than on the other tapping dates. The total gum yield (g/tree) in this season showed highly significant differences ($p < 0.001$) between the tapping dates. The highest total gum yield of 1038.5 g/tree was recorded when the trees were tapped on the 15th of October while the lowest total gum yield of 285.3 g/tree was recorded when the trees were tapped on the 1st of October. The effects of tapping date on *A. senegal* gum yield in the second season 2009 are shown in Table 2. Analysis of variance indicated significant differences ($p < 0.001$) between the dates of tapping on gum arabic yield. Tapping of *A. senegal* trees on the 15th of October and 1st of November gave a yield of 450.8g/picking and 274.6g/picking, respectively, which are significantly higher than on other dates of tapping. The total gum yield in the second season was significantly ($p < 0.001$) affected by the date of tapping. The highest total gum yield of 1629.1 g/tree was recorded when the trees were tapped on 15 November followed by 1110.8 g/tree on 15 October, while the lowest total gum yield of 324.4 g/tree was recorded when the trees were tapped on 1 October.

Table 1. Gum arabic yield (g) in South Kordofan State in relation to date of tapping in 2008/2009

Date of tapping	Gum Yield (g/picking)								Total gum (g/tree)
	1	2	3	4	5	6	7	8	
1 st Oct	4.7	0.0	92.3	82.8	44.4	32.1	20.3	8.7	285.3
15 th Oct	9.5	42.3	375.2	252.7	143.6	96.9	94.6	23.7	1038.5
1 st Nov	48.6	45.6	155.8	107.2	56.9	40.6	18.5	9.1	482.3
15 th Nov	52.2	55.9	84.3	94.2	63.5	44.2	25.0	1.7	421
1 st Dec	45.3	66.4	127.0	116.9	59.8	36.9	0.7	6.7	458.9
15 th Dec	43.1	127.0	83.4	78.4	62.0	0.0	1.3	0.0	395.2
Means	33.9	56.2	153	122.0	71.7	102.7	26.7	8.3	492.8
SE±	11.7*	8.8**	26.0**	18.3**	16.8*	7.9**	5.0**	2.4**	47.2**
C.V %	59.7	36.9	29.4	26.0	40.5	32.8	39.5	57.1	16.6

*Significantly different at ($\alpha=0.05$) and ** significantly different at ($\alpha=0.01$)

Table 2. Gum arabic yield (g) in South Kordofan in relation to date of tapping in 2009/2010

Date of tapping	Gum Yield (g/picking)								Total gum (g/tree)
	1	2	3	4	5	6	7	8	
1 st Oct	4.2	0.0	93.8	75.4	54.4	46.2	25.2	25.2	324.4
15 th Oct	7.5	60.5	450.8	325.5	159.7	78.5	58.2	24.11	1110.8
1 st Nov	34.2	93.0	274.6	161.1	120.0	84.4	54.1	18.7	840.1
15 th Nov	24.2	80.6	235.0	166.1	101.7	72.0	33.2	1.3	1629.1
1 st Dec	29.0	80.4	218.4	192.7	77.3	52.0	0.0	1.0	650.8
15 th Dec	37.0	60.3	197.8	122.3	48.1	0.0	0.0	0.7	466.2
Means	22.7	62.5	245.1	173.8	93.5	55.5	28.4	11.8	766.9
SE±	5.2 **	16.6*	48.8**	32.9**	25.6ns	11.8**	8.1**	3.0**	101.8**
C.V %	39.8	45.9	34.5	32.7	47.4	36.8	49.0	54.6	25.5

* Significantly different at ($\alpha=0.05$) and ** significantly different at ($\alpha=0.01$)

The combined analysis over season for the gum yield (g/picking) and for the total (g/tree) showed significant effects ($p \leq 0.01$) of tapping dates on gum yield (Table 3). The higher total gum yield of 1086.6 (g/tree) was recorded when the *A. senegal* trees were tapped on 15 October followed by 661.2 (g/tree) on 1 November and the lowest gum yield of (386.1 g/tree) was recorded when the trees were tapped on 15 November (Fig. 1). As shown in Figs. 2 and 3, the gum arabic yield is highly governed by the end of the rainy season more than any specific calendar date. The difference in gum yield was attributed to high rainfall in two seasons which ranged between 350–750 mm. Soils of the South Kordofan are almost clay soil ($> 90\%$ clay). Due to the high rainfall in southern Kordofan state the gum arabic trees grow continuously through the end of the rainy season, which may delay the tapping process. Ballal et al. (2005) attributed the variation in gum arabic yield to variation in environmental factors, management practices such as date of tapping,

methods of tapping and tapping intensity, and probably to the variation in the genetic makeup of the trees. The authors reported lower gum yield of *A. senegal* when the trees were tapped late in the season. A reason for the overall low gum productivity of *A. senegal* trees after December tapping can be assumed to be the reduced percentage of available soil moisture as the rain stops in November and soil moisture declines rapidly. In December the percentage of the available moisture is already low which leads to reduction in metabolic activities of the tree and, therefore, to a low rate of gummosis. This result can be used by farmers to gain more yield and to obtain 7–8 gum pickings rather than rely on 4–5 pickings. This result is supported by the results obtained by Gaafar (2005) who concluded that gum production was strongly affected by topsoil moisture content but not by moisture content in the deeper soil layers. In addition, water availability during the rainy season is a limiting factor in the process of gum production.

Table 3. Gum arabic yields (g/picking) in South Kordofan in relation to date of tapping combined over two tapping season

Date of tapping	Gum yield (g/picking)								Total gum (g/tree)
	1	2	3	4	5	6	7	8	
1 st Oct	4.5	0.0	93.1	79.1	49.4	39.1	22.8	10.0	297.9
15 th Oct	8.5	51.4	413.0	215.2	159.7	172.7	140.6	199.0	1086.6
1 st Nov	41.4	69.3	215.2	134.2	88.5	62.5	36.3	13.9	661.2
15 th Nov	38.2	68.2	159.7	130.1	82.6	58.1	29.1	1.5	567.5
1 st Dec	37.1	73.4	172.7	154.8	68.5	44.5	0.3	0.8	552.2
15 th Dec	40.1	49.1	140.6	100.3	55.0	0.0	0.7	0.3	386.1
Means	28.3	51.9	172.4	123.6	83.9	62.8	38.3	37.6	591.9
SE±	6.4**	9.4**	27.6**	26.6**	15.3**	7.1**	4.7**	1.9**	7.0**
C.V %	55.4	44.3	33.9	31.2	45.4	35.8	46.2	56.0	23.2

* Significantly different at (0.05) and ** significantly different at (0.01)

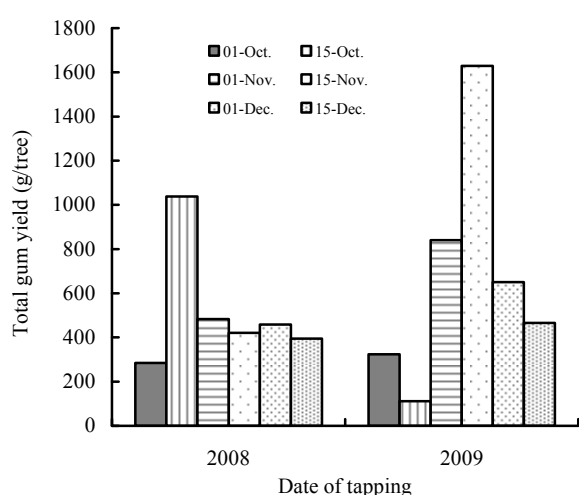


Fig. 1 Total gum arabic yield (g/tree) in relation to tapping date during the growing seasons in 2008 and 2009.

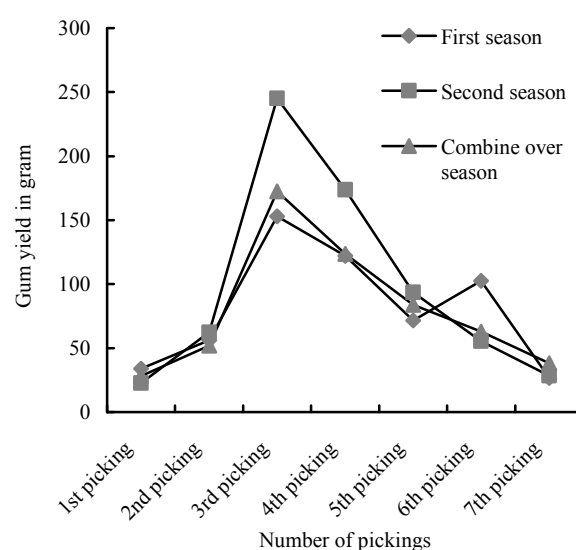


Fig. 2 Trend of the gum arabic yield in South Kordofan in relation to date of tapping

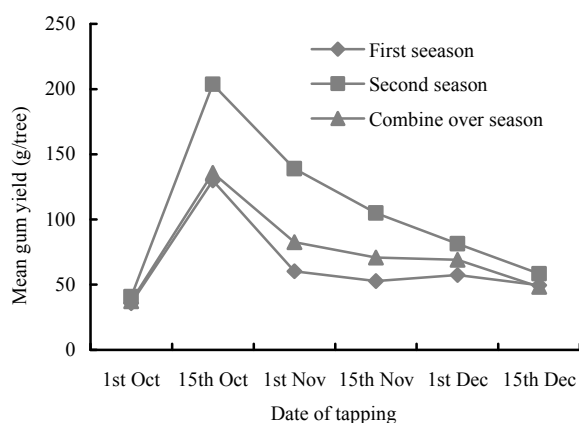


Fig. 3 Mean gum yield in South Kordofan in relation to date of tapping

Conclusion

In the present investigation, *A. senegal* gum yield was greatly influenced by tapping date. The gum yield (g/tree and g/ picking) was significantly higher when the trees were tapped on 15 October and 1 November compared with the other tapping dates. These findings can be used to improve gum arabic yield in southern Kordofan State and increase household income especially during the dry season. This can compensate crop failure. To increase gum arabic production in South Kordofan it is recommended to tap the tree during the period from 15 October to 1 November.

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